beds north of the Carpathians are studied by W. Petrascheck (1912, p. 75), who indicates (p. 92) an interesting groove, parallel with the range, in which they assume an unexpected thickness above the Coal-Measures. The problem of their faulting-down, infolding, or original deposition in a hollow of erosion, reminds us on a smaller scale of that of the Indo-Gangetic plain (see NATURE, vol. xciv., 1914, p. 347). W. von Friedberg, of Lemberg (1912, p. 367) compares the fossil contents of the Polish Miocene with those of Miocene beds in Austria, North Italy, and France, and concludes that the Burdigalian is absent, that the salt-series is Helvetian, and that the Tortonian extends below and also above the gypsum-bearing strata of Podolia. The beds with the brackish-water mollusc Oncophora are held to be somewhat younger than those of Bavaria, and to represent (p. 387) the first arrival of the Miocene sea in Podolia in Upper Helvetian times. References to these beds in Moravia will be found in a note by A. Rzehak (1912, p. 344).

An interesting feature in mountain-structure is shown in sections by G. Geyer (1913, p. 293) of the Toten Gebirge on the border of Styria and Upper Austria, where gypsum-bearing beds have been squeezed up like dykes into limestones of much later date. As an example of critical reviewing, we may cite the extremely valuable summary by F. Katzer (1911, p. 387) of Cvijić's researches in Macedonia and the Balkan peninsula as far as the Dardanelles, which have been mostly published in the Servian language. The origin of the Bosporus-Dardanelles river-cut comes in question (p. 417). We have kept until the last a mention of a discussion by O. Ampferer of Penck's well-known association of terminal moraines and outwash-plains (1912, p. 237). While we think that Ampferer distinctly underestimates the amount of water that may escape from an ice-front of continental magnitude through a loosely piled block-moraine, his citation of the filtering effect of a terminal moraine is distinctly useful. He thus cannot admit the association of a large terminal moraine with an extensive "apron." The two structures, for him, should be in inverse proportion. Ampferer does good service (p. 238) in pointing out an anomaly in Penck's diagram of a double moraine-wall enclosing a "Zungenbecken." This figure has been extensively reproduced, but has puzzled other geologists. How was the outer moraine piled up if the inner one was not destroyed? On the other hand, if it is the older of the two, why do its outwash-products overlie those of the inner wall?

G. A. J. C.

ON SALTS COLOURED BY KATHODE RAYS.[1]

PERHAPS a part of the phenomena which I am about to discuss is already familiar to you all. I shall not bring forward many hypotheses. So you will perhaps ask why I should speak at all. And, in fact, apart from reference to certain facts not published hitherto, my intention is mainly to invite the interest of men younger and abler than myself in a class of phenomena which seem to constitute a new condition of matter, but on which very few have yet worked.

If kathode rays fall on certain salts—for example, common salt, or chloride of potassium, or potassium bromide—vivid colours are produced immediately on these salts.[2] Thus common salt becomes yellow-brown (like amber), potassium chloride turns into a beautiful violet, potassium bromide becomes a deep blue colour quite like copper sulphate. Here you see a specimen of common salt transformed in this way on the surface of the single crystals into a yellow-brown substance. I show also sodium fluoride, which takes a fine rosy colour.

The colours so acquired in a very small fraction of a second may be preserved for a long time, even for many years, if the coloured substances are kept in the dark and at low temperatures. But in the daylight, and also under heat, the colours will gradually disappear until the original white condition is reached again.

The colours of different salts are sensitive to heating in a very different degree. I could show you the yellow sodium chloride, prepared some months ago in Europe, but I cannot show you here the violet KCl and the blue KBr, because these colours, even in the dark, do not stand the heat of the equator. The same salt, if dissolved, may keep very different colours, according to the medium in which it has been dissolved, even when the pure medium itself cannot be coloured at all by kathode rays. I am speaking of *solid solutions,* produced by fusing a small quantity—for instance, of common salt or of certain other alkali salts—together with a great mass of a salt which remains itself colourless in the kathode rays, as, for example, the pure potassium sulphate. Lithium chloride acquires a bright yellow colour in the kathode rays; but if dissolved in potassium sulphate a lilac hue is produced, as you may see in this specimen. Likewise the pure carbonate of potassium acquires a reddish tint, but after dissolving it in the potassium sulphate it becomes a vivid *green* in the kathode rays, as you see here.

Very small admixtures are sufficient to produce intense colours. So 1/25,000 of carbonate will produce the green colour in the potassium sulphate; even 1/100,000 gives a marked colour, and an amount of certain admixtures, which I estimated as 1/1,000,000 only, may produce a slight but quite perceptible coloration in some salts. So if you work with potassium sulphate which you obtain from chemical factories guaranteed as chemically pure, you may observe a set of different colours in these preparations under the kathode rays, by which you will detect the nature of the different small admixtures which adhere to the pretended pure preparations of the different factories. In this way a new analytical proof, much more sensitive than the ordinary chemical methods, is obtained, and impurities may be detected even when a certain specimen of salt contains more than a single impurity, because the colours produced by different admixtures generally disappear with different speed in the daylight or under rise of temperature. For instance, the ordinary potassium sulphate turns to a dark grey with a slight greenish tint at first. After a short while the very sensitive grey will disappear, simply under the ordinary temperature of the laboratory room, and a vivid green comes out. The grey hue indicates a very small amount of sodium chloride, 1/100,000 or so, and the remaining green indicates the admixture of a carbonate. Here are some preparations of potassium sulphate each containing a single small admixture (K_2CO_3, Li_2CO_3, LiCl, KCl, KBr). You will notice how different are the colours of the originally white substance, varying from green to bluish-grey, ash-grey, greyish-blue, and violet.

By fractional crystallisation one may finally get a really pure preparation of potassium sulphate, which is no longer coloured by kathode rays (or only in a very slight degree, indicating minimal traces of sodium chloride). But there are other preparations which, so far as I know, cannot be acquired in pure condition by any means, not even by fractional crystallisation. I never came across a pure sodium sulphate—the purity exists only on the manufacturers' labels. Even the best preparations of this salt contain an amount of sodium carbonate which up to the present cannot be separated from it, not even by frequent fractional crystallisation. The colour produced by the small admixture, which always remains, is a very marked ash-grey. By an intentional further addition of sodium carbonate the colour becomes nearly black.

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[1] By Prof. E. Goldstein. A paper read before Section A of the British Association at the Australian meeting, and ordered by the General Committee of the Association to be printed *in extenso.*

[2] E. Goldstein, *Wiedem. Ann.*, liv., 371; lx., 491; *Phys. Zeitschr.*, iii., 149; *Sitzungsber. Ber. Akad. d. Wiss.*, 1901, 222.

The question arises: What may be the cause of these colorations in pure salts and also in solid solutions of them? Shortly after the colours of the alkali salts had been discovered, an explanation was given,[3] according to which the phenomenon mainly consists in a chemical reduction. For instance, in the case of potassium chloride the chlorine would be set free, while the remaining potassium is dissolved in the unaltered main quantity of the salt, colouring it at the same time. And it seemed a convincing proof for this theory when Giesel[4] and also Kreutz, simply by heating rock salt in the vapours of sodium or of potassium, produced colours in this rock salt quite similar to those produced by kathode rays. It seemed that the problem was settled finally. However, it was soon discovered that the coloured Giesel salts, although they look to the eye quite like the kathode-ray salts, in all other respects behave quite differently. For instance:—

(1) The kathode-ray salts, as I mentioned before, are very sensitive to daylight: after an exposure to diffuse daylight of a few minutes—or in some salts even of several seconds only—the coloration diminishes, whilst the Giesel salts remain unaltered even when they are kept in full sunshine for days or even weeks.

(2) The kathode-ray salts, if dissolved in distilled water, show absolute neutral reaction; the Giesel salts are strongly alkaline.

(3) The kathode-ray salts give very marked photoelectric effects (as Elster and Geitel[5] observed); the Giesel salts are quite ineffective.

(4) In certain circumstances, which will be mentioned further on, the kathode-ray salts may emit a phosphorescent light, the Giesel salts none at all. Therefore the question arose again, Whether there is not a marked internal difference between the kathode-ray salts and the Giesel salts, and what is the nature of the latter?

I have succeeded in settling this question, having produced salts *by kathode rays,* the behaviour of which is in every respect *absolutely identical with that of the Giesel salts.* You may produce such substances if you allow the kathode rays to fall on the original salts not for a short moment only, but for a somewhat prolonged time, *until the salts are strongly heated.* Produced in this way the salts will keep colours; but the substances coloured in this way are *not* sensitive *to light;* they show no photo-electric effect; they give *strong alkaline* reaction, and they are not suited for phosphorescence—all like the Giesel salts. It is quite sure, and you may test it also directly by spectroscopic proof, that in this case, if for instance you have worked on sodium chloride, *the chlorine is set free.* Then, of course, an amount of free sodium is left, which dissolves itself in a deeper layer of unaltered sodium chloride, to which the kathode rays could not penetrate. I call these non-sensitive colours *the after-colours of the second* class, while the ordinary sensitive after-colours, produced in a short time on cool salts, are called after-colours of the first class.

Now, if the after-colours of the second class are identical with those of the Giesel salts, then, of course, the very different substances of the first class cannot be also identical with the Giesel salts. Therefore the question arises anew what is the nature of the first-class after-colours?

One observes with regard to solid solutions that the first-class colours depend not only upon the *metal* contained in the small admixture, but they vary greatly, for instance, in the case of the admixture consisting of potassium chloride or bromide or iodide. This indicates that the metals alone do not cause the after-colours. It becomes much more clear when we expose some ammonium salts to the kathode rays. (The ammonium salts are cooled by liquid air in the discharge-tube to prevent their evaporation.) Then you get strongly marked after-colours likewise; for instance, ammonium chloride becomes yellow-greenish, the bromide becomes yellow-brown, the iodide becomes brown, and the fluoride a deep blue. In the daylight these colours are gradually destroyed, quite like other after-colours of the first class. The colours themselves—yellow-greenish for the chloride, yellow-brown for the bromide, and so on—induce us to presume that the after-colours in this case are produced by the haloids, and not by the hypothetical ammonium radicle. This presumption becomes a strong conviction when we observe that also a great number of organic preparations which contain no metal at all (and not any metal-like radicle) acquire marked after-colours of the first class in the kathode rays also. (The part of the discharge-tube which contains the organic substances is cooled by liquid air.)

Then you may observe that solid acetic acid ($C_2H_4O_2$) remains quite colourless in the kathode rays; but if you substitute a hydrogen atom by chlorine, the substance thus produced (the monochloro-acetic acid) acquires a marked yellow-green after-colour. If you introduce an atom of bromine instead of chlorine, you get $C_2H_3BrO_2$, and the after-colour is of a marked yellow. Bromoform ($CHBr_3$) turns into the colour of loam, and chloral (C_2HCl_3O) becomes a deep yellow. In this way we see that not only salts, but likewise substituted acids, substituted hydrocarbons, and substituted aldehydes acquire after-colours if they contain any haloid.

Now, it seems highly improbable that in the case of alkali salts the electro-positive component is absorbed only (producing the after-colour), and that, on the other hand, in the ammonium salts and in the organic substances the electro-negative component is efficient only. The most probable inference is that in each case *both* components remain and that both are efficient, but that under the same conditions the haloids produce a slighter colour than the metals, so that in the case of the salts the haloid colour is overwhelmed by the metal colour.

Therefore we are compelled to suppose that we have not to deal with a decomposition in the ordinary form, by which the different components are finally separated from each other and at least one of them is set entirely free, but that the components detained by absorption remain at a quite short distance from each other, so that they may easily meet again. I realise that—for instance, in the case of sodium chloride—at every point of the coloured layer there is an atom (or perhaps a molecule) of chlorine and an atom (or a molecule) of sodium; but they cannot combine, because they are fixed by absorption and distended from each other by the absorptive power, which in this case surpasses the chemical affinity. But the absorptive power may be weakened by heating and the chemical affinity or the amplitude of the molecular vibrations may be strengthened by the energy of daylight.

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[3] E. Wiedemann and G. C. Schmidt, *Wied. Ann.*, liv., 618.
[4] F. Giesel, *Ber: D. Chem. Ges.*, xxx., 156.
[5] J. Elster and H. Geitel, *Wied. Ann.*, lix., 487.

If we grant these assumptions, it is immediately evident why the reaction of all dissolved colour substances of the first class is a neutral one, for the two components may combine again and re-establish the original substance. The other special qualities of the first-class colours, and especially their differences from the Giesel salts, which contain the electro-positive component only, may be deduced likewise from this retention of both components and their opportunity of meeting each other again when the absorptive power is weakened or the chemical affinity is strengthened. Now, the two components in the coloured substances being distended in some degree, I propose for this special condition of matter the name of *distension*. If we accept this, have we created a new name only, or does matter in this condition really show new qualities? It seems to me that we have to deal with a peculiar condition of matter, which deserves a more elaborate study than it has met until now. I will not enter again into some special qualities, which have already been mentioned—the photo-electric effect and so on—but I should like to point out that matter in the distension state shows a strongly strengthened absorption of light.

We noticed with regard to ammonium chloride the yellow-greenish after-colour of the chlorine. Now, kathode rays, as used in these experiments, will not penetrate any deeper than one-hundredth of a millimetre into the salt. In such a thin layer even pure liquefied chlorine would not show any perceptible colour. But besides this it must be noticed that we observe this after-colour at the temperature of liquid air, and that chlorine at this temperature, as Dewar and Moissan observed, is snow-white, even in thick layers. In a similar degree the brown colour of bromine is weakened at low temperatures. Now, if nevertheless we observe at this very low temperature the marked characteristic colours of chlorine and bromine, we must conclude that the absorptive power of these substances has become a multiple of its ordinary value. One may observe this strengthening of the absorptive power directly in the pure sulphur. Sulphur likewise turns into a snow-white substance if cooled by liquid air. But when the kathode rays fall on the white sulphur it takes immediately a yellow-reddish colour. It is a real after-colour, because at constant low temperature the colour is destroyed by daylight.

Now, since the strengthening of light absorption occurs in this elementary substance, it becomes evident that the cause cannot be any chemical process, but only a physical allotropy. The special character of this allotropy (which may be connected with an absorption of electrons) will not be entered on in a discussion here. Probably we have to deal with a polymerisation, so that, for instance, the yellow-reddish sulphur would be analogous to polymerised oxygen—to ozone.

I have mentioned already that the first-class after-colours are gradually destroyed by incident daylight. A peculiar phenomenon is connected with this destruction of colour. I found that after the daylight had fallen on the coloured substances, even for the shortest time, most of them showed a marked phosphorescence of long duration. I have observed this phosphorescence even in substances which had been coloured twelve years ago and had been kept in the dark since that time. The diffused dim light of a gloomy November day, when falling through a window on the coloured substance for one or two seconds only, is sufficient for the production of this phosphorescence in a marked degree. If you allow the daylight to fall several times on the same spot, then the colour is weakened at this spot, and we come to the presumption that the loss of coloration is generally attended by the emission of phosphorescent light. This is in accordance with the experience of Wiedemann and Schmidt that if the destruction of the colour is produced by heating, likewise a phosphorescent light is produced, which in this case is strong but of a short duration, corresponding to the quick destruction of the after-colours by strong heating.

If the salts, after having been coloured in the condition of a fine powder and then having been put between two glass plates (in order to obtain a plane surface), are placed in a photographic camera instead of the photographic plate, you may get a fine phosphorescent picture of a landscape or of architecture after a very short exposure.

Time does not allow me to mention in detail several other peculiarities which are shown by matter in the distension state. In one direction only I may be allowed to make some remarks.

The first-class after-colours may be produced not only by kathode rays but also by the β rays of radio-active substances, as you probably know. But they may also be produced by *ultra-violet light,* for instance, by ultra-violet spark light, even when a quartz plate is interposed between the spark and the salt. More than thirty years ago I brought forward a hypothesis, according to which in every point where kathode rays strike a solid body a thin layer of ultra-violet light-radiating molecules is produced in the gas, to which ultra-violet light of very short wave-lengths, for instance, the phosphorescence of the glass walls in the kathode rays, is due. But I came further to the assumption that nearly all effects which are commonly ascribed to special qualities of the kathode rays, and likewise of β rays and X-rays, are mere effects of the ultra-violet light which is produced by the stopping of these rays. I have been guided by this assumption during many years, and have very often been aided by it in foreseeing new phenomena. For instance, in this way I was induced to expect that the after-colours would be produced not only by kathode rays but also by the ordinary ultra-violet light; further I could guess that also the X-rays would produce after-colours (which in this case have been observed by Holzknecht), and in recent times I could foresee that solid aromatic substances (the benzene derivatives) in the ultra-violet light must change their spectra of ordinary phosphorescence, composed of broad bands, and turn to peculiar spectra composed of narrow stripes, the wave-lengths of which are characteristic of the single aromatic substances.[6] So I believe also that the after-colours are produced not directly by the kathode rays or by β rays, but by the aforesaid ultra-violet light which is connected with the stopping of the other rays.

In this way the after-colours enter at once into a great class of phenomena known as *reversible effects of light.* You know that certain effects of the visible spectral rays are destroyed by rays of longer wave-lengths, by the infra-red rays. And the analogy to this phenomenon is in my opinion the destruction of the after-colours: they are produced by the ultra-violet light of the stopped kathode rays and are annihilated by the longer visible wave-lengths of daylight. In this way you may likewise understand, for instance, that the coloured spots, produced by X-rays on the luminescent screens after long exposure, may be destroyed again by exposure of the screens to daylight. You may also explain the peculiar medical observation that therapeutic radium effects in parts of the human body not covered, specially in the face, are often not of long duration—for the face is exposed to the counteracting visible rays of daylight.

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[6] E. Goldstein, *Verhandl. d. D. Physik. Ges.*, xii.

We notice here a connection of our subject with a department of great practical importance. For all therapeutic effects of X-rays, radium rays, and mesothorium rays would, according to this view, be effects only of ultra-violet light produced by the stopping of these rays in the human body, and the special character of the radium- and mesothorium- and X-ray treatment would consist mainly in the carriage into the interior of the body, by the rays, of the ultra-violet light, which is not confined to the surface of the body, but is produced at every place where any of the entering rays are stopped. You may notice further that this view of the medical ray-effects presents a heuristic method for the treatment itself, which up to the present followed quite fortuitous and merely empirical paths. For it may be hoped that treatment by radio-active substances will be useful in every disease in which ultra-violet light has been proved to be efficient in some degree; you will avoid such treatment in the well-known cases in which light of short wave-lengths is noxious, and you may be justified in substituting an ultra-violet light treatment where radium or mesothorium is not obtainable. At the same time it becomes evident why the treatment of certain diseases by the β rays has effects very similar to those produced by *fulguration*—that is, by the light of very strong sparks; the efficient agent is in both cases the ultra-violet light.

But it cannot be a physicist's task to enter too far in medical questions: it was only my intention to show how interesting are some of the problems which are connected with the salts coloured by kathode rays.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

By the will of the late Dr. T. Bell, head of the firm of Messrs. Pyman, Bell, and Co., coal exporters and shipowners, of Newcastle, the sum of 3000*l.* is bequeathed to the Armstrong College, Newcastle.

The report of the proceedings of the general committee for promoting the establishment of an Imperial College of Tropical Agriculture is referred to in the *Pioneer Mail* of December 4. It is stated that Mr. R. N. Lyne, Director of Agriculture, Ceylon, says he thinks that the West Indies will now support Ceylon's claims to be the home of the college. The committee resolved to take steps to raise 40,000*l.* for building and endowing the college, of which 20,000*l.* should be asked from the Governments concerned, including India, and the remainder be raised by public subscriptions, provided Government contribute the share stated. It was also resolved to collect 5000*l.* for the erection of a hotel for European students. The committee has not committed Ceylon for the site; at the same time it favoured that country.

Several bequests for higher education in the United States are announced in the issue of *Science* for December 18 last. Two gifts of 20,000*l.* each have been made for the development of a graduate course in preparation for business and business administration at the Sheffield Scientific School of Yale University. The two donors are graduates of the University. 2000*l.* has been given to Smith College by Mr. and Mrs. A. J. White, of Brooklyn. Half of the money is to be applied toward payment for recent improvements on the Lyman Plant House. A bequest of 2000*l.* to St. Lawrence University at Canton, N.Y., is made under the will of Mrs. Kate A. L. Chapin, of Meriden, Conn. Prof. and Mrs. Frederic S. Lee have given to Columbia University the sum of 4000*l.* to establish a fund for the use of the department of physiology.

SOCIETIES AND ACADEMIES.

London.

Royal Meteorological Society, December 16.—W. F. **Stacey**: The distribution of relative humidity in England and Wales. The author has prepared mean monthly and annual maps of relative humidity based on the 9 a.m. observations made at more than ninety stations during the ten years 1901–1910. An examination of these maps shows that in winter the air over the interior of the country is more moist than that over the coastal regions; that the minimum relative humidity occurs earlier in the year in the western parts of the country than in the eastern; that in summer the air over the interior of the country is drier than that over the coastal regions; and that the smallest range of humidity is found in the west and the greatest in the interior towards the east. The distribution of temperature is the chief determining factor in the distribution of relative humidity; while sea influence, the direction and character of prevailing winds, the configuration of the country all have important effects on temperature, and therefore on relative humidity.

Geological Society, December 16.—Dr. A. Smith Woodward, president, in the chair.—Prof. W. M. Flinders **Petrie**: The Palæolithic age and its climate in Egypt. The classes of worked flints peculiar in Egypt are:—(1) Irregular, with broad unregulated fractures. (2) Rounders, flaked in all directions to an edged disc. (3) Hoofs, very thick, rudely domed with an obtuse edge. (4) Lunes, with obtuse edges. (5) Crescent scrapers. Irregular flints, similar to those from St. Acheul, are found in high Nile gravels. The regular European types occur exactly like those classed as Chellean and Acheulian. The Mousterian forms are so often found in various periods, that they cannot be assigned without evidence of age. The Aurignacian survive into the early civilisation. The large class of flints from the Fayum desert comprises all the Solutrean types, and also Robenhausian forms. The flakes of the early civilisation (8000 to 6000 B.C.) are identical with Magdalenian. Views of the Nile cliffs show the general nature of the country and conditions. Successive changes of level are indicated by (1) the collapse of immense drainage-caverns far below present level; (2) the filling of valleys with débris up to 650 ft. above the present sea-level; (3) the gouging-out of fresh drainage-lines through the filling; and (4) rolled gravels on the top of cliffs 800 ft. above sea-level, since when there has been no perceptible denudation by rain. The great extent of these elevations and depressions is likely to be connected with similar movements at Gibraltar, which are believed to synchronise with the movements of glacial periods in northern Europe. The evidence of the flint ages agrees with this connection.

Paris.

Academy of Sciences, December 14.—M. P Appell in the chair.—E. **Branly**: Intermittent conductivity of thin dielectric plates. A study of the conductivity of a thin plate of dielectric induced by the passage of a rapidly alternating current.—P. **Duhem**: The hydrodynamical paradox of M. Brillouin.—M. C. Jordan was elected vice-president for the year 1915.—M. **Bazy**: Statistical note on tetanus. A study of 129